Appendix D5: Variability and confidence intervals for estimates of fishable biomass.
(During 1974 and 2003-2005, and fishing mortality during 2004-2005)

Reviewers at SARC-43 requested information about the precision of fishable biomass and fishing mortality estimates from camera/bottom trawl survey and landings data. The preferred estimates in the assessment were obtained by pooling data from four camera/bottom trawl surveys during 2003-2005 and using average annual landings during the same years. The analysis described here uses data from each of the four surveys separately.

The first step in the analysis was to tabulate fishable biomass for each survey, strata and depth zone using the data available from each survey. There were a number of "holes" in these tabulations because not all strata and depths were sampled in each survey.

The second step in the analysis was to fill holes in the fishable biomass estimates for each survey with average fishable biomass in the same strata and depth. This step tends to artificially reduce the variability among the surveys but was necessary in order to simulate the preferred estimates which were made from the pooled data set with no holes.

Using the augmented data, fishable biomass for each survey in each stratum was calculated by summing across depths:

$$B_{y,s} = \sum_{d=1}^{5} B_{y,s,d}$$

where $B_{y,s}$ is fishable biomass based on augmented data for stratum s in survey y and d=1 to 5 are depth zones. The total fishable biomass for each survey was calculated by summing across strata:

$$B_y = \sum_{s=1}^{4} B_{y,s}$$

Fishing mortality based on each survey was calculated from the ratio landings and fishable biomass, in particular:

$$F_y = \frac{L}{B_y}$$

where landings L were for the same year as the survey.

The third step was to compute the mean, standard deviation, standard error and CVs for biomass and fishing mortality estimates from each survey (see below). The CV=standard deviation / mean estimates the precision of a biomass estimate from a single camera/bottom trawl survey. The data used to estimate the standard deviation was from surveys during 2003-2005 but, for lack of other information, the standard deviation was used as a measure of precision for the fishable biomass estimate from the 1974 survey. The CV = standard error / mean measures the precision of the pooled biomass and fishing mortality estimates for 2003-2005 based on all four camera/bottom trawl surveys.

| | | Stratum | | | |
Year	A	B	C	D	All
		Fishable biomass (mt)			
2003 June	7,251	1,262	9,222	9,839	27,573
2003 Aug	6,634	1,911	12,850	16,449	37,844
2004	15,590	2,132	9,228	13,918	40,868
2005	8,063	1,620	6,158	22,870	38,712
Average	9,384	1,731	9,364	15,769	36,249
CV std/mean	45%	22%	29%	35%	16%
CV se/mean	22%	11%	15%	17%	8%
		Fishing mortality			
2003 June	0.0709	0.0414	0.0978	0.0459	0.0696
2003 Aug	0.0775	0.0273	0.0702	0.0275	0.0507
2004	0.0350	0.0260	0.1039	0.0345	0.0499
2005	0.0668	0.0338	0.1536	0.0207	0.0520
Average	0.0625	0.0322	0.1064	0.0322	0.0556
CV std/mean	30%	22%	33%	33%	17%
CV se/mean	15%	11%	16%	17%	8%

Fishable biomass estimates from individual surveys during 2003-2005 ranged 28-41 thousand mt while fishing mortality estimates ranged 0.05-0.07 y^{-1}. Based on the CV=8% from the standard error, average fishable biomass and fishing mortality estimates during 2003-2005 were reasonably precise for all survey strata combined. Based on the CV=16% from the standard deviation, the fishable biomass estimate for all strata combined in the 1974 survey was substantially less precise.